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Description of Research Progress

ANNUAL TECHNICAL REPORT

N00014-91-J-1651

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For the Period

June 1, 1991 (Grant start date) - September 1991

Description of Research Progress

1. Nonlinear Characteristics of Superconducting Transmission Lines

It is known that the surface resistivity and the depth of penetration of high Tc superconductor may be dependent on the current density or the surface magnetic field. If a printed transmission line such as a microstrip line is made of these materials, the current distribution in the cross section of the strip can affect the local resistivity. This in turn modifies the current distribution. Hence, this is a nonlinear problem. A modified spectral domain method in combination with the iteration process was developed which can analyze the propagation characteristics of the superconducting planar transmission lines. The first step is to modify the spectral domain method in such a way that the position dependent surface resistance is included in the formulation. Next, in order to invoke the standard spectral domain format, the current distribution is expressed in terms of Fourier transforms of the subsectional basis functions. For an assumed current distribution, an iteration process is initiated with an assumption that the surface resistance is constant. After the current distribution is obtained, the surface resistance is readjusted and the process continues until convergence is reached.

2. Pulse Propagation in Superconducting Coplanar Striplines

A linear filter approach was used for characterizing the fast pulse propagation along a superconducting planar transmission line. In this approach, each element appearing in the exponent of the propagation characteristics is represented as a linear filter. Hence, from the frequency characteristic data, the time domain response is easily found as that of the corresponding linear filter. Essentially, the attenuation and dispersion of the transmission line are incorporated to characterize the pulse propagation. The accurate characterization of the high Tc superconducting film is carried out by adopting the "enhanced" two-fluid model which is an engineering approach recently developed in the Soviet Union. This approach was first adopted in the western world. The results based on this approach was found to provide very good numerical prediction confirmed by comparison with experimental data. Based on this approach, the conductor attenuation of the strip line is characterized by the phenomenological loss equivalence method (PEM) developed by the PI's research group. The attenuation due to this contribution is modeled by a linear filter. A dynamic characterization of radiation loss and the conventional dielectric loss are incorporated individually as linear filters. The dispersion is also modeled by a linear filter. Simple relationship between the peak attenuation and delay time of the propagation pulse, and the depth of penetration at absolute zero temperature and conductivity at the critical temperature may open the possibility of using pulse distortion to characterize thin-film high Tc superconducting materials.

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List of Publications, Presentations and Honors

Submitted under separate cover.